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14. ABSTRACT
Textron Defense Systems and its subcontractors have been developing a Geocultural service, a software framework and inferencing engine for the Transparent Urban Structures program. The scope of the effort has evolved as the program has matured and is including multiple data sources, as well as interfaces out to the ONR architectural framework. Tasks also include additional development in the areas of Geocultural and Anthropological ontologies.

15. SUBJECT TERMS
API Application Programming Interface; Application Program Interface; Application Programmer Interface
CAF Common Application Framework
EDA Event Driven Architecture

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ONR Transparent Urban Structures: Decision Aids Using Heterogeneous Intelligence Analysis Option 1 (Year 2)

Final Report

Contract #: N00014-08-C-0244

Submittal Revision: -

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Table 1-1: Revisions

Document Number	Release/Revision:	Release/Revision Date:
TUS-FIN-0002	-	08/20/10

1 Documentation Roadmap

This Final Report is organized into the following sections:

- **Section 1 ("Documentation Roadmap")** provides information about this document and its intended audience. It provides the document overview and describes the content of each section.
- **Section 2 ("Program Overview/Review")** provides a summary of schedules and milestones achieved during the year by phase.
- **Section 3 ("Option Year Technical Overview")** a technical overview of the option year effort, from an architectural and implementation perspective. Interaction with other ONR performers and testing accomplished are also summarized.
- **Section 4 ("Results, Conclusions and Next Steps")** summarizes overall status, lessons learned and presents goals and objectives for the second option year.
- **Section 5 ("Acronym List")** provides an acronym list.

1.1 Document Management and Configuration Control Information

- Revision Number: -
- Revision Release Date: 08/20/10
- Purpose of Revision: Initial Release
- Scope of Revision: N/A

1.2 Purpose and Scope

This Final Report provides a summary of work done under the ONR Transparent Urban Structures contract in the first Option Year of the program. The team is comprised of Textron Defense Systems, Natural Selection Inc, the U.S. Army Engineering Research and Development Center (ERDC), and anthropologist Liam Murphy.

The first six weeks of the contract, the team was integrating and executing the ISR-C2 demonstration at the MEC in Kaneohe, Hawaii. Section 3.1 will provide a brief overview and lessons learned from this exercise. These lessons learned fueled the development effort that followed, leading through the Empire Challenge 2010 (EC10), Green Devil II (GDII) exercise at Ft Huachuca in August 2010.

The ensuing development effort was a continuous effort, not designated into phases. However, upon receiving details and direction regarding Empire Challenge 2010 (EC10), most efforts were geared toward that goal as we progressed through the program. This document will provide a summary of activities, architecture, functionality and initial results from the EC10/GDII exercise.

2 PROGRAM OVERVIEW/REVIEW

This section reviews programmatics.

2.1 SCHEDULES

Figure 2-1 shows the executed schedule for the Option year.

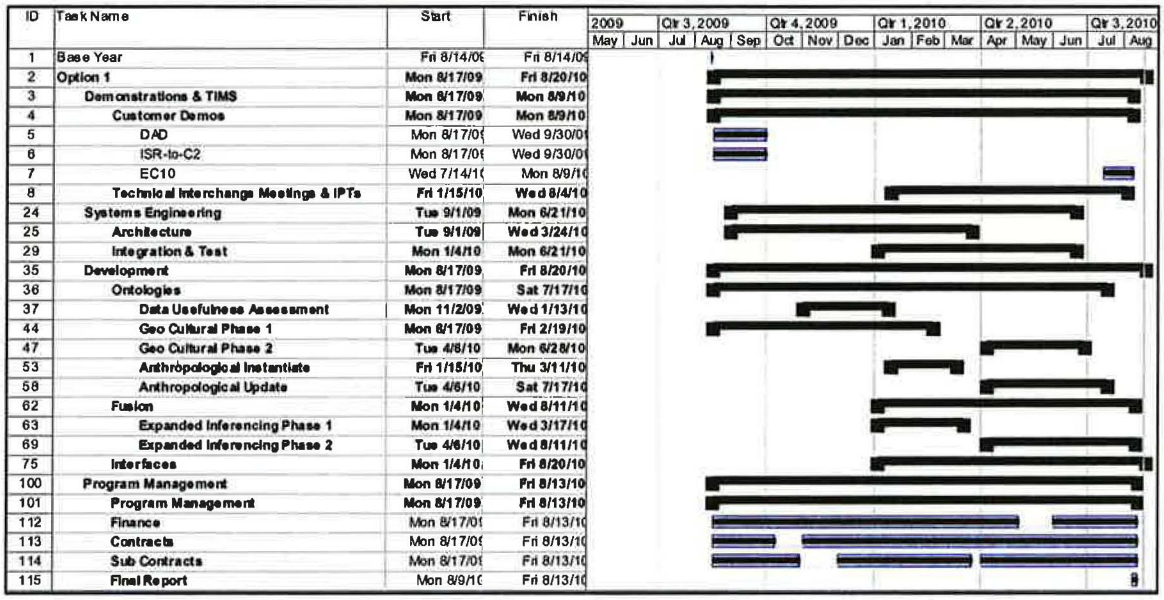

Figure 2-1: Option Year Schedule

Table 2-1 summarizes statused milestones for the program Option year.

Technical Milestones/Tasks	Baseline Completeion Date	Revised/Planned Completion Date	Actual Completion Date
Customer Demos	JUL 10	AUG 10	AUG 10
TIMS	MAR 10, AUG 10	MAR 10, AUG 10	----
Architecture	MAR 10	MAR 10	MAY 10
Integration and Test	JUN 10	JUL 10	JUL 10
Ontologies	JUL 10	JUL 10	JUN 10
Fusion/Inferencing	AUG 10	AUG 10	JUL 10
Interfaces	AUG 10	AUG 10	JUL 10

Table 2-1: Statused Option Year Milestones

TIMs: No Technical Interchange Meetings occurred in the Option Year, however, Textron Systems participated in four (4) IPTs in preparation for the EC10 demonstration: Ontology, Architecture, Analysis, and ISR-to-C2 and in the EC10 Demonstration itself..

Architecture: Completion of this task was delayed as the ONR team (including performers) determined the EC10 architecture.

Ontologies: Since moving to an Android platform resulted in us moving toward a database driven architecture rather than ontology driven architecture, thus work in this area finished early.

Fusion/Inferencing: The basic rule contructs completed in July, most detailed rules were written as we learned about the EC10 scenario.

Interfaces: System integration culminated in an integration exercise at Raytheon in July.

2.2 Meetings Summary

The Option year program had a defined set of periodic meetings that are all documented with meeting minutes. These meetings included:

- Weekly Team meetings with subcontractors
- Monthly program review with Textron Senior management
- Monthly Teleconference with ONR, through December 2009. Minutes have been distributed to ONR.

2.3 Documents

Reporting

- Monthly Spend Report 9/2009 - 8/2010
- Monthly Financial Report 9/2009 - 8/2010
- Monthly Internal Review Slides and Meeting Minutes 9/2009 - 7/2010

Contractual

- Textron /ONR SOW TS-W8C03 (AV04) REV A – 14 December 2009
- Contract MOD 4-P00003-03 November 2009

Deliverables

- Textron Option Year Final Report, TUS-FIN-0002, 20 August 2010

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3 OPTION YEAR TECHNICAL OVERVIEW

The concept behind the Textron Geo-Cultural Service has remained the same from Base year to Option year, however, the implementation platform changed and thus we were able to add additional features and interfaces with other performers to extend the capabilities provided to the ONR enterprise and Marine user.

The option year began with the ISR-C2 exercise in Hawaii, the assessment of which led to two areas of work. First, we needed to better focus the types of data we were assessing for the Warfighter as there is a lot of 'who cares' data. A series of questionairres were developed in support of this. The Android was also brought forward as a desireable platform for Textron's software, by bringing capabilities directly to the Marine.

The Option year architecture focuses on using the Android Smartphone Operating System, via the Motorola Droid, and being able to alert the Marine of Geo-Cultural anomolies. The android platform as demonstrated at EC10 provides a variety of user interfaces and ways for the Marine to access geocultural and anthropological data and inference via applications running on it in real-time. The solution also provides the capability to capture observations and multimedia to distribute to peer Android users and other consumers/performers in classified and unclassified space. This functionality was developed, integrated and tested, but not all of it demonstrated at EC10.

The new focus on Android brought with it several questions of how the Warfighter would receive the device and how the capability was presented. To help us better understand what might and might not work in terms of useful interfaces, we leveraged Textron military and retired military personnel whenever possible to get feedback on functionality and utility. EC10 provided an even better opportunity to get user feedback from active duty personnel for future work in this area.

3.1 ISR-C2 DEMO OVERVIEW

The ISR-C2 demo at the MEC in Kaneohe, Hawaii in September 2009 provided the first opportunity for the Textron team to demonstrate its Ontology basded anthropological and geocultural rules based inferencing technology. The initial architecture was developed to provide a queriable backend system to support the Marine in real-time, providing the ability to assess threat significance of certain observation and activities. Textron integrated with Raytheons DKKN and leveraged data from various sources to provide initial demonstrable capabilities. The architecture for the exercise has already been presented in Textron's Base Year final report. A lot was learned in the exercise in terms of integrating with other performers and becoming part of the ONR TUS/LTSN enterprise network. There were two critical lessons learned that dictated what was done for the remainder of the Option Year 1 effort.

In general there is a lot of cultural and anthropological data available to inundate the modern Marine. There are several problems with it. First, a lot of it is not terribly useful in a tactical environment or for a Marine on patrol. Perhaps a planner, an analyst or Commander would have a much different perspective. Second, cultural and anthropolocgical data is very hard to present effectively or provide in a useful fashion to a consumer at any echelon. Thus the first thrust for Textron was to focus on understanding these issues better and apply them to the Marine on the street, our first subject.

Much of the ISR-C2 field effort was plagued by communications issues. This is reality in a tactical and especially urban environment; not something to complain about but something to adapt to. In the exercise outbrief, it was suggested that we put our applications and tools directly in the Marines hand by adapting our work to smartphone platforms. We instilled requirements on ourselves that we be able to exercise 80% of our functionality without any communications or network and that we do it on an Android platform.

3.2 Data Assessment

Comments from the base year contract and the ISR-C2 demo, led us to begin the next phase by assessing what data would be most critical or useful for the Marine user. Starting with the GIRH (5/5/2009), Textron added cultural and anthropological elements to develop a questionairre for assessing usefulness of various types of data. Eight (8) different users representing the Marine Corps, Special Forces, the Army and the Navy Seals participated in completing two levels of questionaires (results of the first allowed further drill down with a second). Table 3-1 provides a high level summary of those elements considered most useful to a Warfighter. The higher the utility number, the more important it is.

Table 3-1: End User Questionnaire Results

ID	Data Category	Data	Utility to Warfighter
	URBAN AREA		
1	**Issues**	Political Climate	5.0
2	**Key Figures**	Government	9.0
3		Military	7.0
4		Opposition	9.0
5		Tribal	9.0
6		Criminal	5.0
7	**American Sentiment**	Population demographics	5.0
8		Extremeists	5.0
9		Media	6.3
10	**Urban Geographic Locations**	Criminal/Gang neigborhoods	6.3
11		Anti-american areas	9.0
12		Tribal neighborhoods	7.0
13		Insurgent neighborhods	9.0
14		Locations of recent conflict	9.0
15	**Social Traits/Values**	Firearms	6.3
16		Security	6.3
17	**Taboos**	Verbal	7.0
18		Gestures	7.0
19		Activities (e.g. drinking,proselytizing, solicitation)	5.0
20	**Significant Dates**	Importance	6.3
21		Non-verbal communications	7.0
22		Slang	5.0
23	**Customs**	Greetings	5.0
24		Negotiating	5.0
25		Manners	5.0
26	**Tribal Clan Structure**	Basis of affiliation (religious, political, crimi-	5.0

ID	Data Category	Data	Utility to Warfighter
		nal....)	
27		Boundaries	7.0
28		Biases	5.0
29		Roles in conflict	5.0
30		Key Personnel	7.0
31		Insurgent Affiliation	7.0
32	**Political Structure**	Insurgent Affiliation	9.0
33		Key personnel	5.0
34	**Law Enforcement Structure**	Protection of property.people	6.3
35		Insurgent Affiliation	7.0
36		Military Affiliation	7.0
37		Coalition Affiliation	7.0
38	**Identification**	National: Passport, Visa	7.0
39		Military	7.0
40		Driving	7.0
41		Forgery	7.0
42	**Habitat/Geography**	Town layout: living, shopping, economy	7.0
43		Population Movement and migrations	5.0
44		Land use	5.0
45		Topographic landmarks	9.0
46	**Air/sea/land customs procedures**	Bribery	7.0
	URBAN INFRASTRUCTURES		
47	**Police or military units with police authority/mission.**	Locations and borders	7.0
48		Structure	5.0
49		Leaders	7.0
50		Communications	5.0
51		Proficiency	5.0
52		Corruption	5.0
53		Patrols	7.0
54		Curfews	7.0
55		Hours	7.0
56	**Roads**	Critcal roads and intersections	5.0
57		Usage patterns	5.0
58	**Bridges**	Location	7.0
59		Usage	5.0
60		Alternate routes	7.0
61	**Subterainian features**	Tunnels	7.0
62		Sewers	5.0
63	**Power Plants**	Significance: Capacity, coverage area	5.0
64		Security	5.0
65	**Communications Facilities**	type (radio TV, satellite, cell)	7.0
66		location	7.0
67		Security	7.0
68		Vulnerabiliy	9.0
69	**Overall Communications Capabilities**	Police	5.0
70		Fire	5.0
71		Military	5.0
72		Insurgent	9.0

ID	Data Category	Data	Utility to Warfighter
73	Use of infrastructure to mask/camoflage threats	Location	9.0
	SYMBOLS		
74	**Images, descriptions and/or metadata**	Key people	9.0
75		Grafitii	7.0
76		Vehicles; common types, cohort association, status symbols	7.0
77		Cultural objects	5.0
78		Flags and banners	7.0
79		Weapons	9.0
80		Murals/pictures/billboards	5.0
81		signage or markers	5.0
82		Age features, clothing, colors, body art and jewelry, uniforms	5.0
83		Clan features, clothing, colors, body art and jewelry, uniforms	7.0
84		Military, Police features, clothing, colors, body art and jewelry, uniforms	7.0
85		Insurgent features, clothing, colors, body art and jewelry, uniforms	7.0
86		Gang features, clothing, colors, body art and jewelry, uniforms	7.0
87		Group vehicle associations	7.0
88	**Behaviors/gestures**	Appropriate	5.0
89		Inappropriate	5.0
90		Group specific mores or behaviors	5.0
91		Displays of agression	7.0
92	**Sounds**	Background noise types or descriptions	7.0
93		Human background noise: quiet, noisy, screams....	7.0
94		Songs/chants	5.0
95		Weapon/explosive dis-charge:normal/abnormal, types, times	9.0
96		Dialects, swears, key indicator words	7.0
97	**Temporal: Cyclical**	Schedules	5.0
98		Seasons	5.0
99		Associated practices and behaviorsfor each of the above	7.0
100	**Temporal: Crisis**	Typical crisis behaviors (before during after)	7.0
101		Any group behaviors/interactions that may be triggered by a crisis	6.0
102	**Buildings and Spaces**	Government	5.0
103		Military	5.0
104		Police	7.0
105		Markets	5.0
106		Commercial	5.0
107		Restaurants	5.0
108		Religious	5.0
109		Education	5.0
110		Factories	5.0
111		City Infrastructure	5.0

ID	Data Category	Data	Utility to Warfighter
112		Streets	7.0
113		Parks	5.0
114		Symbolism or cultural significance	7.0
115		Clan, Tribal affiliations	9.0

Additional assessments were done relative to different phases of an operation and various echelons consuming the data that are not presented here, but will likely have future use.

3.3 REQUIREMENTS & REQUIREMENTS COVERAGE

The high-level technical requirements for the Option Year:

1. *The Textron solution shall provide similar functionality as base year, but should be implemented on a Droid*: Geo-cultural and anthropology data stores were made mission specific to reduce the amount of data on the Droid. There are currently no inferencing engines available that run on Android; all rules for geo-cultural inferencing were developed in standard JAVA.
2. *The Textron solution shall provide cultural and anthropological lookup capabilities*: Various options are provided in the system for doing database lookups. Data can be looked up on a map with events or geographically significant locations showing up as push pins on the map. They can be selected and assessed in detail. The VIZ, augmented reality tool can provide similar access to detailed data. Additionally categorized data with thumbnail multimedia can be browsed and looked at in detail.
3. *The Textron solution shall provide data capture capabilities including multimedia:* Input screens allow a user to capture data in the forms of: pictures, audio, hand entered text and guided questions. This data is position and time tagged automatically. The majority of the data is needed for inferencing, the rest is needed to provide complete event entry insofar as it can provide utility to the Warfighter (i.e. multimedia).
4. *The system shall provide most of its functionality without a network connection*: All cultural inferencing can be done locally, with no network connection. Maps are loaded locally, databases are updated and stored locally, and rules are executed locally.
5. *Loss of network connectivity shall not impact performance*: An Android service was developed to control data flow to the network. Connectivity is tested prior to sending data. Data is queued for a configurable period of time if network is unavailable.
6. *System shall be integrated with the ONR enterprise systems and tools for 2010 demonstration:* Connectivity and data flow for EC10 was demonstrated by the Textron software.
7. *The Textron solution shall minimize network bandwidth utilization:* The current Textron design does not send multimedia such as images and audio in the EntityID messages. Instead URLs to the Android Webserver are used allowing a user to reach back for multimedia if desired. Feedback from EC10 indicates a preference for sending multimedia.
8. *The Textron solution shall minimize user interaction:* While keyboard entry of metadata is allowed, Textron developed a series of guided questions to minimize user interaction.

All GUI threads were developed trying to minimize user activity. Initial feedback from EC10 was that more reduction is needed. Other feedback was that capabilities exceeded what was needed for a reconaisance Marine; some capabilities were better suited for the CoC analyst. It appears the system needs to be tailored to match different echelons. Voice control of the Android is a long term option also.

9. *The Textron solution shall interface with DKKN*: The system was integrated with Raytheon DKKN and chat as well as the ONR messaging infrastructure. Alerts and observations are sent as EntityID messages embedded in ONR Metadata messages. When DKKN receives them they strip off the ONR Metadata message. The EntityID message is then forwarded to the unclassified GHUB.
10. *The Textron solutions shall get data to GHub and across the guard to the classified GHub:* At EC10, EntityID messages were placed in the unclassified GHUB and forwarded across the Guard and placed in the classified GHUB. There they are available to provide input to other users (i.e. KBSI, Metron, and Chi Systems in the future) as well as trigger Gumballs on the Tactical Switchboard (although not confirmed at EC10).
11. *The Textron solution shall get data to other Androids*: When DKKN receives an EntityID message from Textron they copy the Textron data fields into a chat message and send to unclassified chat users This was developed and tested but not demonstrated at Empire Challenge.

3.4 ARCHITECTURES

Textron is buillding a piece of the ONR enterprise architecture, not a standalone component. Thus our architecture is dependant on what/who we interface to. The following three section give and overview of the ONR arcthiecture, the Textron Architecture and the components used to build that architecture.

3.4.1 THE ONR ARCHITECTURE

The Textron applications or Android Apps reside in both the ***Data Sources*** and the ***Application Services*** layers of the objective ONR ISR architecture shown in Figure 3-1. The Android enables the Marine, as a sensor, to record observations in both scripted (structured questions) and free-formed (typed metadata) formats. Multimedia such as images and audio data can also be captured and stored in the Android SQL database with the observations. Observations are input to the Android inferencing App which leverages local cultural and anthropological data, to be assessed. The App then either generates an alert or passes the observation on to consumers. Both the Alerts and the Observations are sent through DKKN to the Central Repository layer. Alerts are sent to other users in the network via DKKN and are mapped along with other system alerts in DKKN.

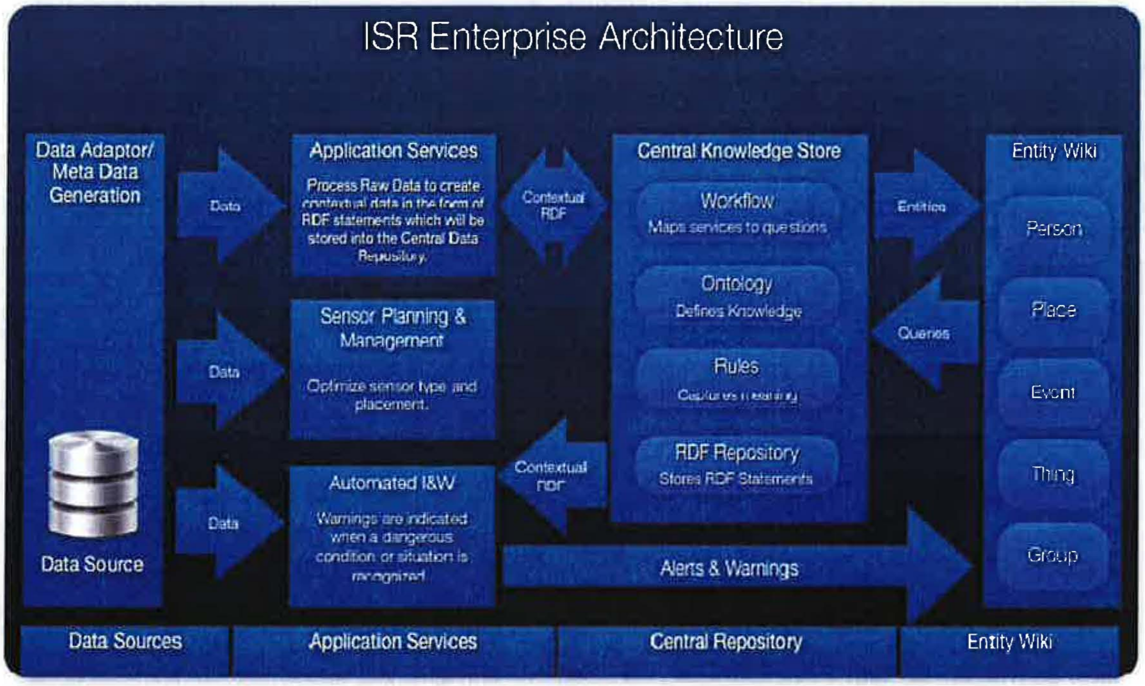


Figure 3-1: ISR Enterprise Architecture

Embedded EntityID messages are the transport for both message types with DKKN providing translation services to the GHUB and to chat messaging, which distributes the content of the messages to the other Androids and chat users, Figure 3-2.

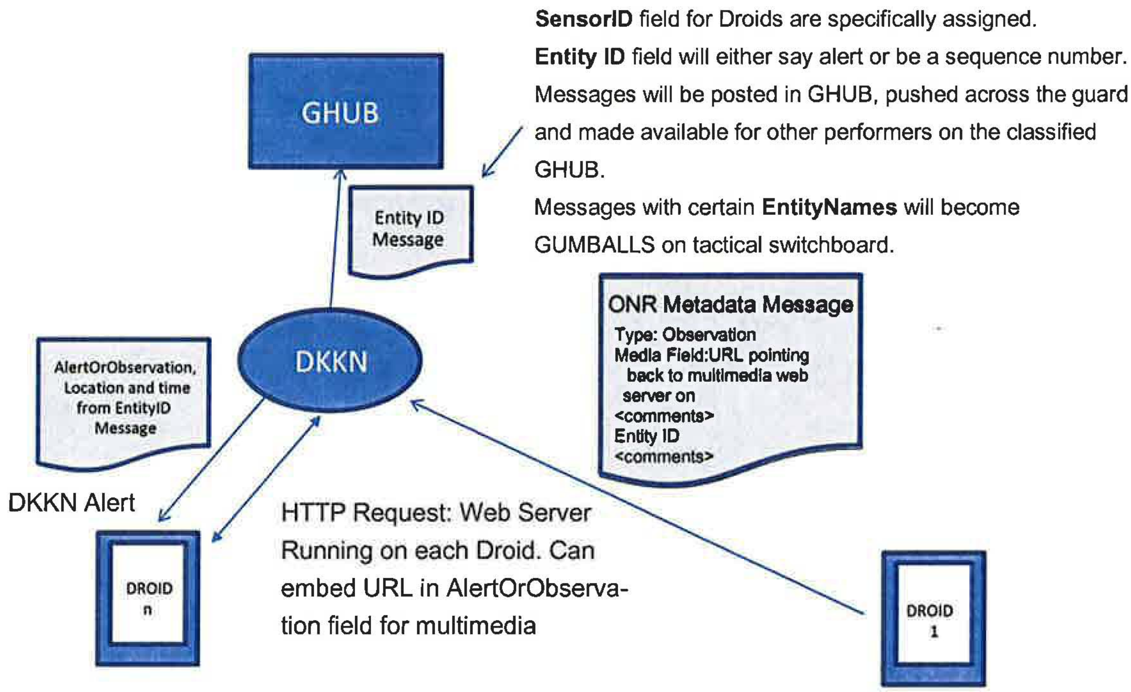


Figure 3-2: Textron Droid Data Flow within Enterprise

DKKN removes the EntityID message payload from the ONR metadata message received from the Textron Android App. The message details such as the type, and specific content, along with position, time and possible multimedia URL are packaged in a chat message for distribution on the unclassified network to other Androids or hosts. The EntityID message is then posted to GHUB, pushed across the guard and posted on classified GHUB. Alert messages or those with an EntityName "ALERTEX" (for general alert or "ALERT_*FIRSTNAME_LASTNAME*" (for person sighting) will then also intitiate a Gumball on the Tactical Switchboard.

3.4.2 TEXTRON ANDROID ARCHITECTURE

The Textron Android Apps provide the Marine with:

- Network Independence
    - Maps and databases local on device (3.5.1 and 3.5.2)
    - Store and Forward when network available
    - Minimized use of network bandwidth (multimedia provided upon request only)
- Scripted and freeform event entry with multimedia (3.5.3).
- Geo-cultural inferencing and look-up (3.5.2.1 and 3.5.4).
- Map, augmented reality and list views of normal events, Warfighter observations, anthropology, cultural, and geo-data (3.5.2).
- On board web server provides multimedia reach back from desktop/laptop platforms. Ultimately from other handhelds.
- Sending alerts and observations to applications and servers both classified and unclassified.

To enable all of this, several COTS and developed technolgies and tools were utilized in the implementation of the Android-based architecture, Figure 3-3. The compents of the Android architecture are:

Map GUI - uses the Nutiteq API to access, zoom and display locally stored map levels.

Location Service - maintains current position information to support data input requirements and tracks user position over time.

Event Input - provides not only direct user input but also time tagging, geotagging and multimedia input. Any inferencing is done here with output generated to the database, multimedia store and other consumers through the *message service.*

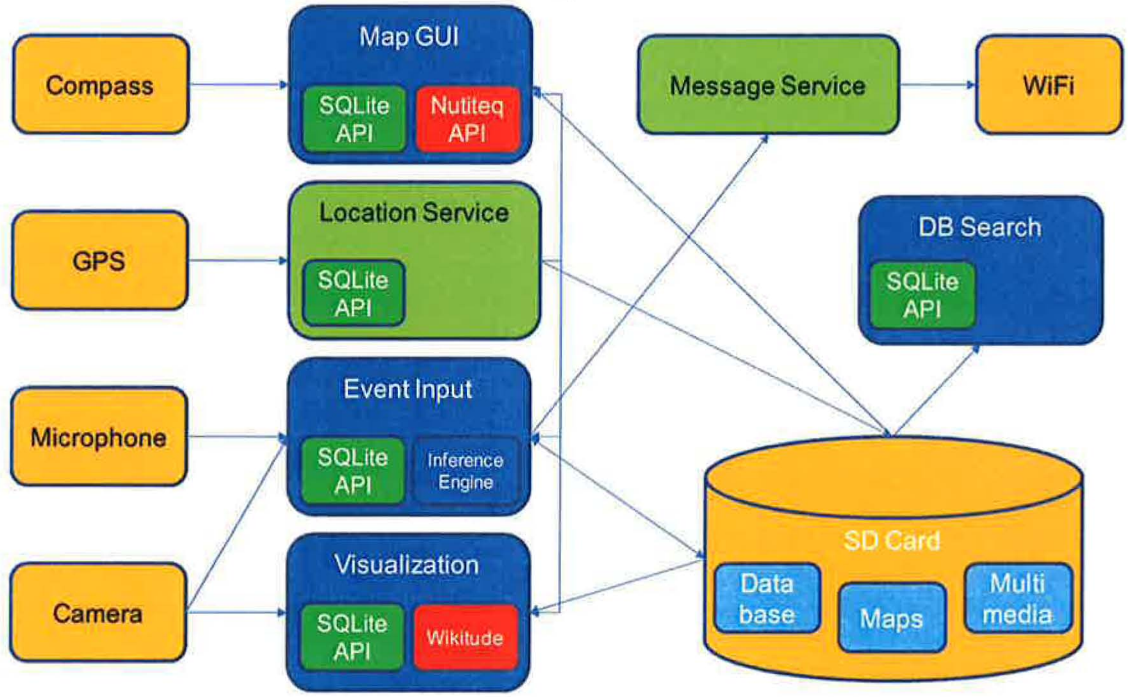
Visualization Service - includes all the Android Activities such as menu screens, data screens and the augmented reality screens.

Message Service - allows the system to perform under limited or no connectivity situations for all data output. It queues messages and tests periodically for connectivity, sending data only when the network is available.

Database API - used to provide contextual overlays on maps and augmented reality (Viz).

SD Card – card was used for storage of all operational data. The Android operating system imposes numerous restrictions on user access and remote access to the primary storage on the device. The SD card can be easily accessed via USB from another host and is write accessible to all.

In addition to those Activities and Services shown, a web server runs on the Android to provide URLS for media retrieval. The intent is to minimize network bandwidth utilization where possible. Currently the server only works correctly from host to Android not Android to Android. This functionality is contrained based on the COTS product(s) being used, iJetty.



Orange = Droid HW; Blue = Textron Developed UI; Light Green = Textron Developed Services;
Dark Green = Android Provided API; Red = 3rd Party API; Light Blue = Files

Figure 3-3: Android Architecture

3.4.3 Architecture Components

A number of commercial off the self components (hardware and software) were combined with custom development to realize the architecture for EC10. These are briefly listed and discussed below:

COTS Components

Android OS – A Linux based OS with Google JAVA application development framework. Environment enables leveraging of multiple apps within one app and includes an emulator for development. Version 2.1 was used for this option year.

Motorola Droid

- Arm® Cortex™ A8 processor 550 mHz
- 3.7-in.; WVGA (480 x 854 pixels); 16:9 widescreen display
- 16GB micro SD card (supports 32GB)
- GPS
- 802.11 b, g
- 5Mpixel camera with dual LED flash
- Multiple data input methods (keyboard, touch screen, stylus, camera, microphone)

iJetty – Web server allowing reach back for images and audio. This is an on-demand service to reduce burden on network. Current version does not work phone-to-phone for images but does for phone-to-desktop/laptop platforms.

Wikitude - Mobile augmented reality (AR) browser that displays points of interest (POIs) on top of the phone's camera view

NutiTeq – Mobile mapping SDK

SQLlite – Cross-platform public domain self-contained, serverless, zero-configuration, transactional SQL database engine

Internally Developed Software

System loading, configuration, and updating: Software for installing Apps, providing custom configuration and updating the database and mapping system

User interfaces: Custom interfaces including map overlays, radio buttons and controls, data display of combine metadata and mutimedia

Database schema: Schema for cultural data, anthropological data, geographic data, event data, key figures, tracks and multimedia

Inferencing framework and ruleset: There are no inferencing engines currently available for the platform. A custom framework with rules was developed in JAVA

Location and tracking manager: time position and time to objects and track enitities ovber time

Integrated combination of Android *content providers*, *services* and *activities*: A working system required efficient implementation and integration of software and capabilities from multiple sources

Message construction and queueing: Build ONR metadata messages, EntityID messages and handle communications queuing

3.5 THE APP COMPONENTS

The app is database driven. This section starts out with an overview of the database structure. Subsequent sections show the databases realization as GUI's and visualization techniques in the App.

3.5.1 DATABASE

To transition to an Android-based system, the Geo-cultural, anthropological and geo-data databases from the base year had to be transferred to a Droid. Those databases, as they existed were quite large. To reduce the size of the database, we chose to provide a user with only mission-specific information. This would allow them to not only save valuable space on the Android, but would make the datasets small enough that the user can also manually search through the databases if desired, which extends the app to more than just an inferencing tool. Ultimately full databases would be kept only on a wirebased host and an Android would be loaded with minimal mission capabilities for a specific time and place.

To extend the value of the inference and provide additional look-up features, we also created a key figures, groups/tribes, events and multimedia tables to leverage the onboard camera capabilty of the Android when capturing events for inferences. These pictures aren't used in inferencing, but again, provide the user with valuable lookup tool if stored with supporting data.

The database schema is shown in Figure 3-4. The following tables are the main tables of the database.

Normal Events (Geocultural): The Geocultural part of the database includes information pertaining to religious and state holidays, cyclical cultural events, usage of buildings (including hours of operation), and government and political and religious practices. Many of the entries are intended to be referenced to the Geodata to provide usage data on particular locations. Entries may also incorporate multimedia. A text field describes relevant information. Table 3-2 shows an eample entry.

Table 3-2: Sample Normal Event (Geo-Cultural) Table

ID	Title	Metadata	Multimedia ID	Loc ID
6	Eid-al-Fitr	Islamic Holiday: lasts 3 days in most places; an official public holiday of 1 or more days in 62 countries; celebrates end of the Ramadan fast; customarily, all gather in festive clothes. School, businesses closed. No work. May witness prayer events.	210	827

*Supporting Tables: Location, Multimedia

Geodata: Geodata defines locations and objects in space and defines their types such as building types, landspace types and structures. For EC10, Geodata was collected for buildings at the Battletown MOUT, site STTW and Site Boston from program provided Google Earth file EC10_Green_Devil_v10_052110.kmz. Specifically a LAT/LON for each corner of the buildings was determined. Ultimately the format should be in MGRS coordinates.

*Supporting Tables: Geotypes, Location

Anthropology: The Anthropology database contains various types of anthropology data including:

- Animal
- Activities
- Symbols and flags
- Vehicles
- Posters and Leaflets
- Graffitti
- Migration
- Food
- Gathering
- Prayer
- Sounds
- Objects
- Gestures
- Speech
- Signs

Much of it has associated multimedia such as pictures of graffitti and signage or examples of any of the entries. Table 3-3 illustrates a typical entry.

Table 3-3: Sample Anthropology Entry

ID	Type	Metadata	Multimedia ID
12	Animals	Men on horseback fighting. These are features of 'buzkashi': the Afghan national sport, in which skilled horsemen must snatch a headless goat/cattle carcass, circle the field and drop it in a scoring circle while members of his team assist and members of opposite team try to take the carcass from him	17

*Supporting Tables: Source Type, Anthropology Type, Multimedia

Key Figures: The key figures database contains images and metadata for key figures as well as associations with the groups and tribes database. It may include multiple associated images and thus multimedia IDs. Typical Metadata could be: *"An associate of al-Qaida leader Osama bin Laden who was in charge of foreign al-Qaida militants, especially those operating in Pakistan's tribal regions near Afghanistan."*

*Supporting Tables: Tribal_Clan (aka Groups/Tribes), Multimedia

Events: Events are divided into types or Event Classifications to enable scripted data entry questions for reduced user interaction and to assist in inferencing formats. The current types are as follows with the asterisk indicating an evet involved in inferencing:

- Attack/Attempted Attack*
- Cache Found/Cleared
- Detainment
- Disturbance*
- Gathering*
- Intimidation/Murder
- Observed Object
- Other
- Person Sighting*
- Propaganda/Graffiti
- Traffic*
- Vehicle Sighting*

*Supporting Tables: Location, Multimedia, Event Classification

Tribal_Clan (aka Groups/Tribes): Descriptions and affiliations of groups with metadata. Multiple locations can be associated to designate neighborhoods or regions where they have some presence

*Supporting Table: Location, Multimedia

Multimedia: Multimedia itself does actually not reside in the database. A database table links multimedia IDs to files resident on the microSD card.

*Supporting Table: Location

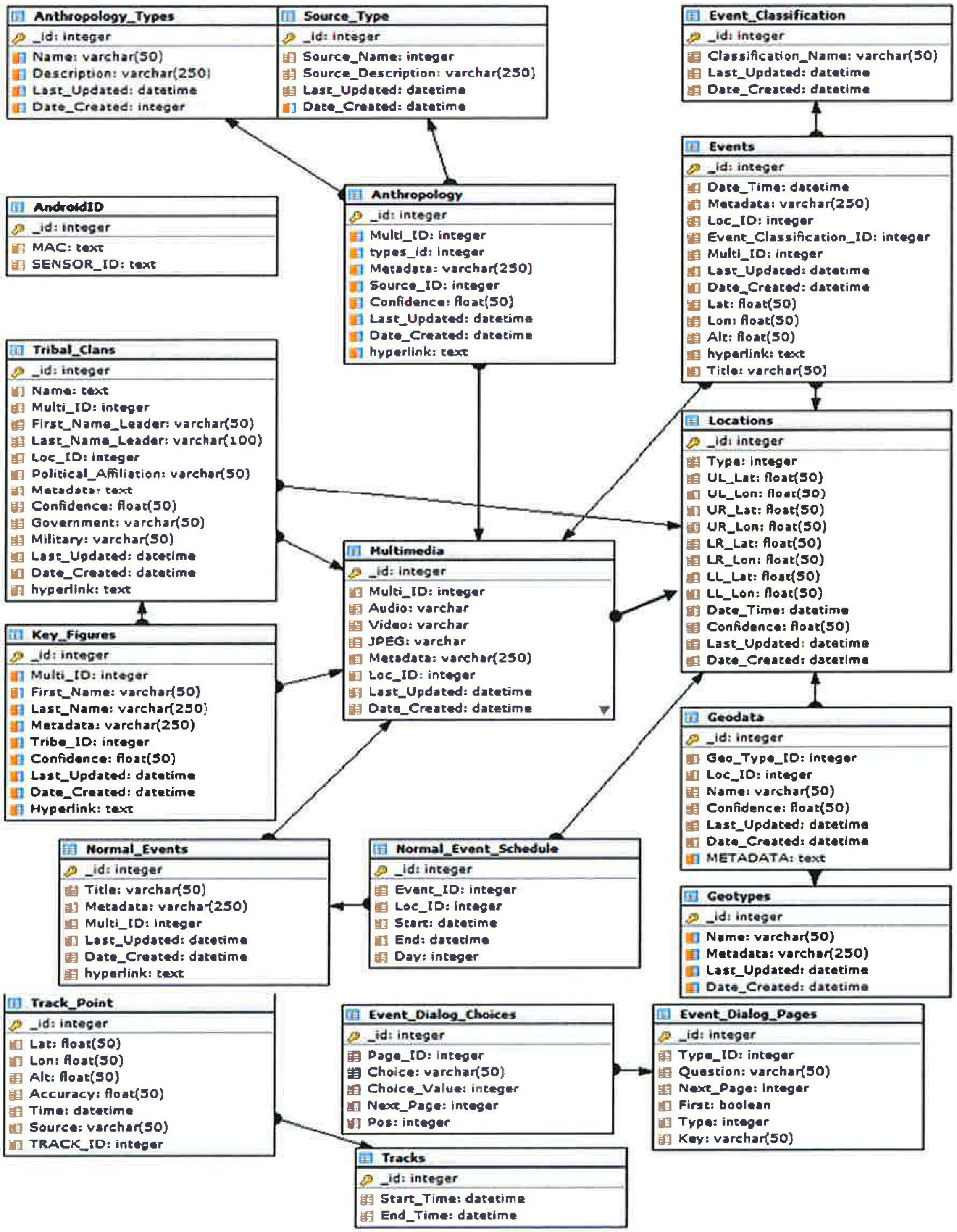


Figure 3-4: Database Schema

3.5.2 VISUALIZATION/GUI'S

Three different vizualization techniques are used for data or events.

1. List views (used for look-ups) with image thumbnails can be used to search through topics.
2. Map views can be used to look at geo-located data.
3. Augmented reality is available where the Android can be used as an orientation based viewer of the immediate surroundings with data or events appearing as drillable icons in the display.

3.5.2.1 List Views/Look-ups

List views/look-ups can be done in several areas.

From the *Cultural Look-Up* option:

Symbols (Geocultural and Anthropological): information is listed by topic and (like other data) may or may not include multimedia.

Key Figures can include cultural figures from local pop culture, political figures, and known/suspected insurgents, and other persons of interest. The database can be updated based on observations/events at the end of a mission, as it was at EC10.

Groups and Tribes similarly, this table contains local groups, tribes, clans. Metadata about them as well as where there geographic boundaries are, etc.

Your Events contains a list of any data that the user entered through the *Report Event* feature.

From the *Main Menu:*

View Normal gives lists of either proximity and/or time based normal cultural activities to understand immediate surroundings.

Figure 3-5 is a snapshot of the top level menu all the way down to the fourth and fifth level of detail. From the main menu, each of the five (5) options can be access directly through the touch screen. Some of the areas are also connected internally with Maps showing events and cultural information through drill down and other categories leveraging the Maps for display.

Figure 3-5: Top=Menus; Middle=High Level List; Bottom=Detail

Figure 3-5 illustrates the capabilities under the *Cultural Look-up* activity. The *Key Figures* activity allows one to scroll through the database of figures viewing thumbnails and the beginning of the figure metadata. Selecting one of the entries brings up a full screen picture and text display. Multiple pictures can be accessed and additional audio multimedia can be selected. The *Groups and Tribes* activity provides a similar drill down of summaries and detailed descriptions with multimedia. The *Symbols* activitiy provides access to the *Anthropology* database as described in

3.5.1. At the top level it allows selection of *Symbol* type leading to thumbnail lists with summaries and to detailed information screens. Finally is the *Your Events* activity which provides the same type of summary and detailed information with multimedia for accessing events captured on the local Android. Follow on work will be targeted at synchronizing these events between multiple Androids and other applications or performers. Potentially, the databases could be syched based on unit, location, echelon or other interest group.

Figure 3-6 shows the details of the View Normal feature. As with other list, there is a top level list with the ability to drill down for multimedia, notes and schedule for the activity. A time or location filter can be applied to focus the list on current location or current day.

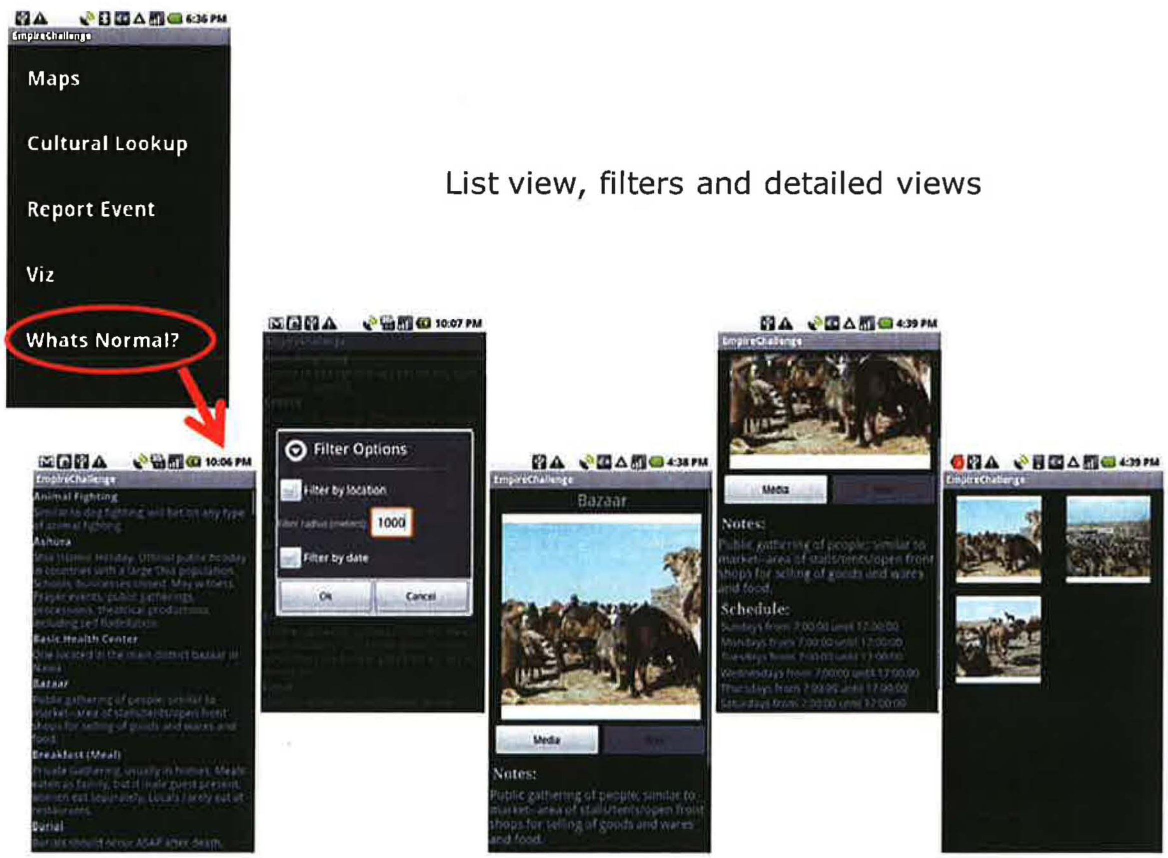


Figure 3-6: "What's Normal?" Screen Shots

3.5.2.2 Maps

The mapping capability provides mission specific map information zoomable from level 3 to level 17. All maps are loaded on the Android prior to a mission to eliminate a dependancy on internet connectivity. Four differnet views are available and can be selected through the menu for the current *Activity.* Repeatedly selecting the first opyion toggles through the map types, Map, Satellite, Hybrid and Terrain. Figure 3-7 and Figure 3-8 show the views and also illustrate the map icons used to indicate current location and events.

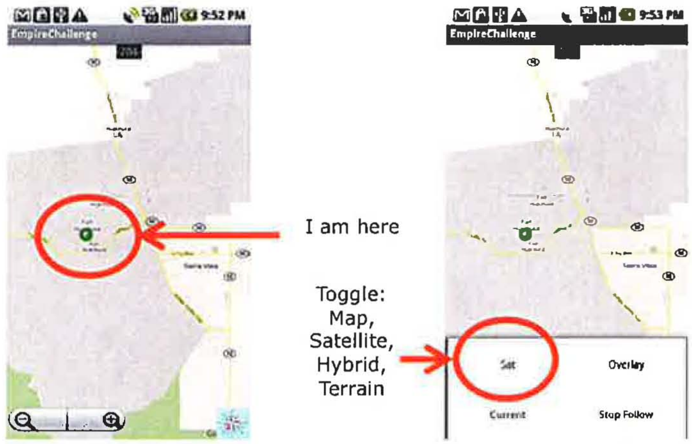


Figure 3-7: Map Views and Types

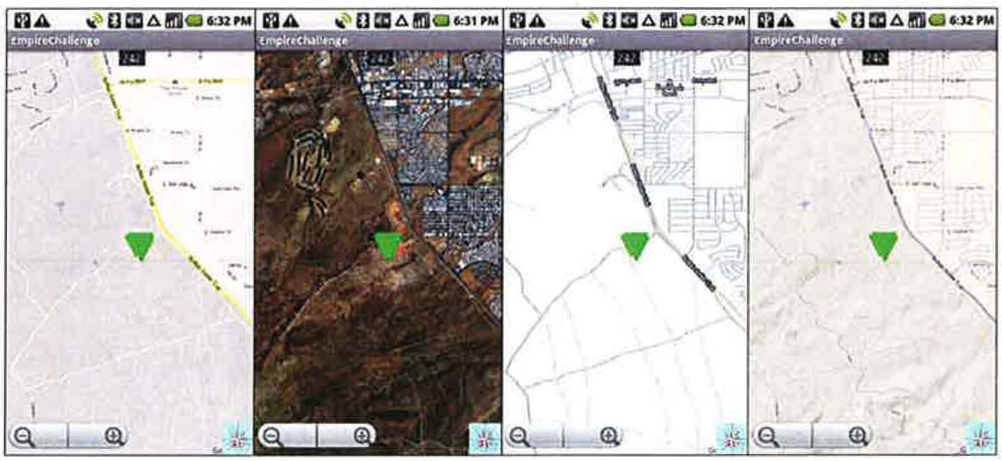


Figure 3-8: Map Views: Standard Map, Satellite, Hybrid, Terrain

Figure 3-9 illustrates the different overlays that can be selected. Currently the *Events* overlay displays events on the local Android, although objectively this will inlclude events from other Androids and other data sources such as sensors. The overlays are: Events, Peers (other Androids), Tracks (where have I and other users been), Diameters (define the active event display range), Alerts with a time window, and Geotypes (position and type data from the Geodata database.

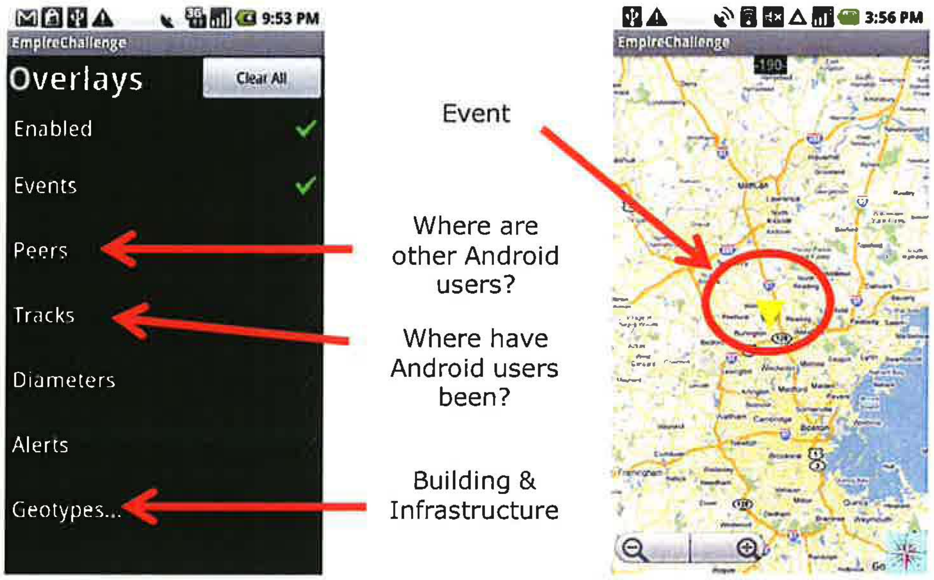


Figure 3-9: Map Overlays

3.5.2.3 VIZ: Augmented Reality

The VIZ tool adds an augmented reality view, where geolocated events or object markers are overlaid on a live Android camera image. By aiming the camera at an area, the image appears on the screen with "balloon" boxes where events have occurred. One can pan around the environment and visualize where things have happened. A compass is displayed to provide orientation. Selecting the balloon leads to detailed information about the event.

Figure 3-10: Augmented Reality Showing Events Overlayed on Camera Image

3.5.3 Data Entry

With all the inferencing taking place on the Android, there needed to be a formatted input mechanism for the user to drive the rules. To that end, we created a front end GUI to allow the user to enter his/her observations by generating free form metadata. This metadata is not used for inferencing but is saved with the observation for reporting. Each observation is then qualified and detailed through a series of questions that are responded to by touching radio buttons. This structured metadata is used for inferencing. Figure 3-11 shows the top level entry screen for capturing metadata as well as the audio metadata and imagery capture screens. These features use the onboard Droid mcrophone and camera.

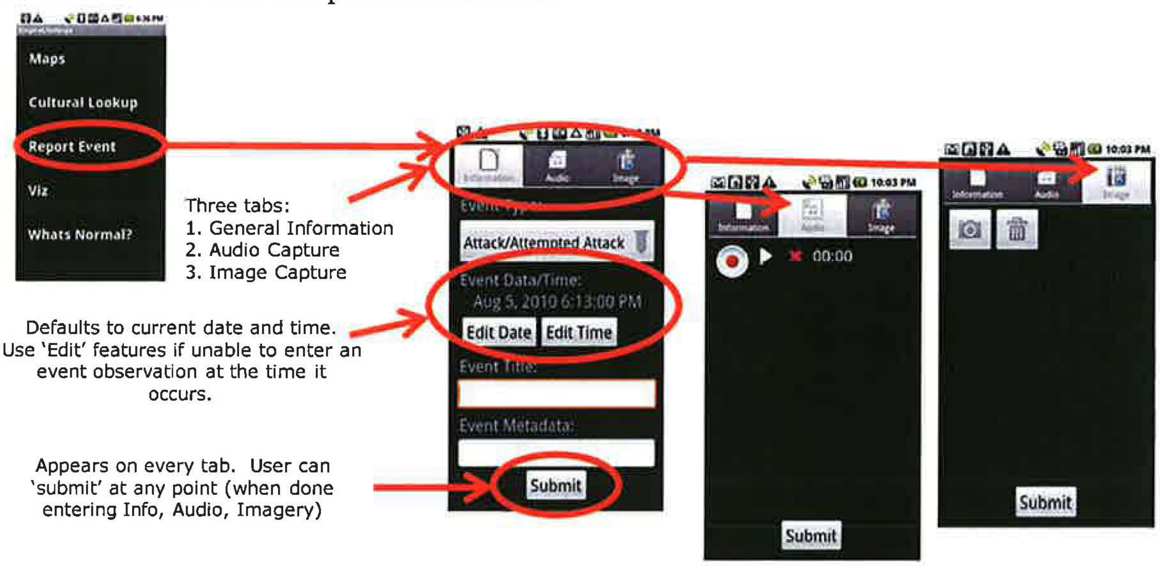


Figure 3-11: Report Event Screens – Main Input, Audio Capture and Image Capture

As the Marine observes events of interest, there is a mechanism for them to enter the event into the database and trigger the inferencing rules to see if that observation is normal, abnormal, or unknown.

The questions used to qualify the events are based on what geo-cultural and anthrolopoligical characterists can help determine normality of such an event. Table 3-4 illustrates the event categories and questions developed for EC10. Touching next walks the user through a sequence of screens.

Table 3-4: Event Entry: Types and Qualifiers

Event Type	Attributes	
Attack/Attempted Attack		
	Successful Attack?	
		Yes
		No
	Type	
		CF Engagement
		Direct Fire
		IED Attack
		IED Found/Cleared
		Indirect Fire
		Unexploded Ordinance
		Unknown Explosion
	Injuries?	
		Yes

Event Type	Attributes

- No
- \# ppl attacking
  - 0-10
  - 10-20
  - 20-30
  - 30-40
  - 40-50
  - 50+
- Type of arms
  - Small Arms
  - Sniper Rifle
  - Machine Gun
  - Rocket
  - Mortar

Traffic

- Type of Traffic Observation
  - General Traffic Change
  - Traffic Abnormality
    - Who's participating in the abnormal behavior?
      - Some
      - Most
      - All
      - None
- Traffic Type (select one or more significant types)
  - Cars
  - Trucks
  - Pedestrian
    - Choose one or more...
    - Men
    - Women
    - Children
  - Motorcycles
  - Other (Bicycle, Animal, Cart)
  - None
- Traffic Volume
  - Low
  - Medium
  - High
- Traffic Speed (Relative)
  - Slow
  - Medium
  - Fast
- Traffic Direction Movement (choose one or more - to support bi-directionality)
  - 1 North
  - South
  - East
  - West
  - 2 One Way Towards person/place

Event Type	Attributes

- One Way Away from person/place
- BiDirectional

Origin or Endpoint
- Teahouse
- Residence
- Mosque
- Intersection
- Market/Commercial
- Observer/Individual?
- Unknown

Gathering

Type
- Labor/Working
- Religious
- Meals/Tea
- Shopping
- Celebration
- Demonstration
- Riot
- Kneeling
- Procession - line(s) of people
- Loitering

Who's involved? (select one or more)
- Men
- Women
- Children

Size
- Small
- Medium
- Large

Participation Level
- Some
- Most
- All
- None

Location Description
- Outdoors
- Residence
- Commercial
- Meals/Tea
- Religious Structure

Generic Behavior
- Friendly
- Avoidance
- Hostile
- Passive
- Dis-Interested

...

Event Type	Attributes

...
...

Disturbance

- Type
  - Harrassment/Intimidation
  - Gunfire
  - Shouting
  - Chanting
  - Music
  - Riot
  - Fighting
- Where?
  - Current Location
  - Immediate Area
  - Near
  - Distant
- Direction
  - North
  - South
  - East
  - West

Person Sighting

- Person #1, ...#i, ...#n
  - ...List of key figures in database
  - Other
    - Name (if known)
    - Gender
      - Male
      - Female
    - Age
      - Child (< 12 yrs)
      - Adolescent (12-19 yrs)
      - Adult (20+ years)
- What accessories/belongings do they have? (Select 1 or more)
  - Tools
  - Weapons
  - Cell Phone
  - Radio
  - Baggage
- What are they doing?
  - Kneeling
  - Acting Alone
  - Running
  - Digging
  - Walking
  - Meeting with Others
  - Surveillance

Event Type	Attributes
	Other?
	Enter text?
	Generic Behavior
	Friendly
	Avoidance
	Hostile
	Passive
	Dis-Interested
	...
	...
	...
	Add another person?
	Yes
	No
Object Sighting	
	Object #1, ...#i, ...#n
	...view of anthro look-up screens
	Other
	Free Text/Audio/Visual Description
	Add another object?
	Yes
	No
Vehicle Sighting	
	Color
	Make
	Model
	Other Descriptors
	What was it doling?
Other	
	Free Text/Audio/Visual Description
Cache Found/Cleared	
	Contents of Cache
	What was done with it?
	Description of location
	How they found it
	Metadata
Intimidation/Murder	
	Time - if different from time of data entry
	Location - if different from current location
	What happened? Type of intimidation (i.e. harrassment)
	Who did it
	Who was victim
Propaganda/Graffiti	

Event Type	Attributes
	Time - if different from time of data entry Location - if different from current location What was found What does it say/mean?
Detainment	
	Time of detainment - if different from time of data entry Location of detainment - if different from current location Name of detainee Description of detainee Reason for detainment

3.5.4 Rules: Inferencing Engine

During the first year of the TUS program, Geocultural and Anthropological event assessment used an inference system based upon the JBOSS/Drools engine. This software has its own rules language and specific operating system requirements. All first year development was performed using PC laptop computers running the Microsoft Windows operating system. Rules were written for this implementation and demonstrated at the TUS experiment during September 2009 at the MEC in Kaneohe, Hawaii.

Per guidance from Martin Kruger, development moved toward an implementation that could be demonstrated on a handheld smartphone such as an Android device (e.g., cell phone). The Android platform with its linux-based Android O/S was selected from among the available handheld platforms with programmable computational capabilities. Assessment of available software Apps for the android was done to locate an inferencing engine but none were found although the community was interested. The android does have sufficient Java-based programming capabilities to support development of a basic Java-based logical-chaining inference machine via functional blocks of 'if-then-else' rules.

Storage and acess constraints led to a decision to utilize two separate information mechanisms to acquire input data. Data required to support the inference engine functionality was derived from the SQL database but implemented as a parallel construct. Another constraint was based on the dynamic or non-dynamic nature of the SQLlite database. Thus lack of state data limited rule development to inferences on singleton, atomic events, although a method to inference on multiple events that were input within a single 'time-stamp' was later implemented.

The aforementioned constraints and the experience (lessons learned) during the previous MEC experiment led to developing inferencing software centered around the generation of a flexible construct that would permit rapid generation, modification, and utilization of rules on the Android. The basic inference engine was designed to fire rules that accept event objects (e.g., traffic event) along with a time stamp and location information (i.e., where the event was observed). Rule-firing outputs consisted of a message containing status (normal or abnormal), rationale (reason the rule fired), and confidence (e.g., high, medium, low) in the asserted inference.

Another key design aspect was the use of rules as objects themselves, which enabled encapsulating them within a standard Java vector container. By restricting all rules to utilize identical input and output structures, rule sets could be loaded if/as required into this vector. Essentially the vector provides what are effectively function pointers to rules. A simple iterator then operates over all rules for the specific input object class. Rules that are not specific to an object class are thus skipped preventing erroneous or unexpected results. After loading all of the desired rules into the input vector, a driver method loops over all input events and passes each one through the set of rules. Output inferences are then stored in a results vector that is available for output display.

Inferences can be viewed as logical correlations between existing information and previously seen patterns, predictions, and or logic-chains. In light of the available event information, rules were developed based upon current-time and/or proximity associations, linkages, and known geocultural/anthropological information. Lacking the ability to store and access existing state information (i.e., data from previous inputs and/or results) precluded backward chaining and use of true cross-event temporal inferences.

Several base classes were developed to support the matrix of anthropological and geocultural knowledge as well as the available input events to the system. These base classes consisted of

Attack
Disturbance
Gathering
Person Sighting
Traffic
Vehicle Sighting

Rules are described using a simplified 'if-then' construct. Nominal times are demonstrated per information specified for EC10 experiment vignettes. Also note that many 'positive' rules have an associated 'complement' rule that fires when conditions are outside of the normative event times, dates, locations, etc. Following are some example rules used at the EC10 demonstration:

Dog Fighting - If (shouting and/or fighting is heard in the immediate area on a Thursday from 3pm through 4:00pm), then it implies a NORMAL situation since a dog fight is scheduled for this date/time.

Buzkashi - If (shouting and/or fighting is heard in the immediate area on a Tuesday from 2pm through 3:00pm), then it implies a NORMAL situation since a Buzkashi match is scheduled for this date/time.

Harassment - If (harassment of local people is observed in the current location at any time) then this implies an ABNORMAL situation since it is indicative of potential insurgent activity.

Daily Prayer - If (ALL observed men, women, and/or children are participating in religious activities at 7:00am, 10:00am, 1:00pm, 4:00pm, 7:00pm Saturday through Thursday) then this implies a NORMAL situation as these are daily prayer times observed by ALL local personnel.

Daily Prayer - If (NOT all observed men, women, and/or children are participating in religious activities at 7:00am, 10:00am, 1:00pm, 4:00pm, 7:00pm Saturday through Thursday) then this implies an ABNORMAL situation as these are daily prayer times should be observed by ALL local personnel.

Tribe-B Person Sighted in Village A - If (a male from Village B is observed in Village A) then this is an ABNORMAL situation since the villagers do not normally associate with each other due to mutual hostilities. (NOTE: this rule originally included a time-frame filter that required disabling due to the performance constraints of the EC10 vignettes.)

Mosque - If (a general traffic change consisting of mostly people or cars is observed transiting to the Mosque during Friday Prayer Time) then this is a NORMAL situation since everyone should be attending Mosque prayers during this timeframe. (NOTE: this rule originally included a timeframe filter that required disabling due to the performance constraints of the EC10 vignettes.)

Pakol - If (a male is observed in the immediate area and is identified as Pakol) then this is an ABNORMAL situation since this is an associate of a known insurgent. (NOTE: this rule originally included a timeframe filter and a location-specific filter that required disabling due to the performance constraints of the EC10 vignettes.)

SUV-618 - If (vehicle color is red and type is SUV and license contains "618" and the vehicle is observed in the market) then this indicates an ABNORMAL situation since this vehicle is associated with known insurgent drivers.

During the EC10 exercise, we quickly learned the rule sets designed from the original suppositions and vignette information were largely obviated since temporal information was no longer part of the scenario execution. In addition to this change, location-specific rules required modification and or disuse due to the fact that no specific building functions were designated. Despite these changes, the rules-generation framework worked well as it permitted generation of new rules in a short period of time as information about the actual vignettes was revealed to our team. The Marines were capable of generating inferences based on their inputs after minimal training.

3.5.5 OUTPUT

The inferencing rules generate an output that is either the result of an inference, or if no result a pass through of the input data. Thus the result is either normal, abnormal or no result. The results are presented to the Marine, but also meant for outside consumption. Two types of data are output, either and Alert or an Observation. The output form is an EntityID XML message. The XML schema for the EntityID message is shown in Figure 3-12. The *SensorID* field is used to specify the messages as coming from and Android. Position and time are filled out by the *Message Service*. The *EntityName* field is set to indicate the message type. If it says Alert it indicates an alert to downstream applications. Otherwise it is filled out with a unique sequence number generated by the app. The *AlertOrObservation* field is used to state the basic results of the inference or a statement of the observation. Included in here is a URL for Multimedia Reachback into the Android. The *BackUpFacts* field is used to provide additional information relevant to the event such as the answers to the questions that were asked upon data input.

The EntityID message is wrapped in an ONR Metadata Message for transport to DKKN. DKKN removes the wrapper and sends the message to the unclassified GHUB. It is then transferred across the guard to the classified GHUB for use by other performers and the Tactical

Switchboard. DKKN also removes the Android specific content from the message and sends it out as a chat message, including the URL. Again, this functionality was tested during integration at Raytheon in July, but not demonstrated at EC10.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<ltsn:EntityIdentMessage xmlns:ism="urn:us:gov:ic:ism:v2" xmlns:ltsn
  <Security ism:ownerProducer="USA" ism:releasableTo="USA" ism:class
  <CommDeviceID>CommDeviceID</CommDeviceID>
  <SensorID>SensorID</SensorID>
  <Time>2001-12-31T12:00:00</Time>
  <Location>
    <Latitude>0.0</Latitude>
    <LatitudeUncertainty>0.0</LatitudeUncertainty>
    <Longitude>0.0</Longitude>
    <LongitudeUncertainty>0.0</LongitudeUncertainty>
    <Altitude>0.0</Altitude>
    <AltitudeUncertainty>0.0</AltitudeUncertainty>
    <AltitudeUnits>Meters</AltitudeUnits>
  </Location>
  <EntityFeatures>
    <EntityName>EntityName</EntityName>
    <AssociationID>0</AssociationID>
    <MatchConfidence>0.0</MatchConfidence>
    <VideoSensorInfo>...
    <AudioSensorMicArrayInfo>...
    <VideoDetectionInfo>...
    <AudioSensorInfoDOA>...
    <AudioDetectInfo>...
    <AudioInfoMfccSegs>...
    <VoiceTranscript>...
    <AudioVideoAssociation>...
    <FacialRecognitionInfo>...
    <LinkedIdent>...
    <GaitRecognitionString>...
    <Biometrics>...
    <TTL>...
    <AudioPrint>...
    <ThroughTheWall>...
    <VehicleID>...
    <VehicleDismountAssoc>...
    <GeoCulturalDroid>
      <AlertOrObservationID>1</AlertOrObservationID>
      <AlertOrObservation>AlertOrObservation</AlertOrObservation>
      <BackUpFacts>BackUpFacts</BackUpFacts>
    </GeoCulturalDroid>
  <RelatedLink>http://tempuri.org</RelatedLink>
  <CanonicalURI>token</CanonicalURI>
</ltsn:EntityIdentMessage>
```


Figure 3-12: ONR EntityID Message Schema

3.6 Testing

The Android OS was a new and different development enviroment, paradigm and contained new hardware. We had this and other COTS tools to learn and test before being able to successfully develop our system. When feasibility could be demonstrated, software development started with a focus on modularity. Individual Activities and Services and base capabilities were developed and tested independently and then integrated and tested as a system. This modularity will make future enhancements and changes easier to implement.

Enterprise sytem interfaces were designed and developed early through continuous conversations with Raytheon to ensure we were developing in a way that suited the enterprise. In parallel, we developed and tested interfaces with DKKN as well as messaging constructs per the ONR guidance. Although the guidance changed over time, the plumbing to move data existed and was tested.

System level integration and testing was performed on site at Raytheon on July 19th and 20th. There, we were able to demonstrate message construction within the Textron App, delivery to DKKN, message deconstruction and rebuilding for the enterprise as EntityID messages and also message delivery to Android users via notifications and chat as well as to Ghub users. As the message schema continued to change, we simply adjusted the schema.

Testing and tweaking continued throughout EC10, August 2-13.

3.7 Demonstration

Objectives:

1. Demonstrate multiple ways in which the app can provide geo-cultural context and actionable intelligence to the Warfighter.
    a. Data collection and inferencing (with alerts to the Warfighter)
    b. Look-ups
    c. Visualization
2. Demonstrate the app working as part of the ISR Enterprise
    a. Integrated alerts with DKKN: to the CoC and other Android users
    b. Multimedia reachback
    c. Messages succesfully cross the guard and are visible on Tactical Switchboard
3. Demonstrate output being consumed by other analysis tools
4. Obtain feedback regarding usability and relevance to the Warfighter

Results: Corresponding to the items above…

1. ***Demonstrate multiples ways in which the app can provide geo-cultural context and actionable intelligence to the Warfighter:*** Some methods of providing geo-cultural and anthropological context were more used than others.
    a. ***Data collection and inferencing (with alerts to the Warfighter)***: Data collection was used nearly every day to capure location of symbols, signs,

propaganda, key figures, and key events (such as person sightings, detainments, vehicle sightings, etc).

On Day 2 of EC10/GDII, Marines were able to identify Hafiz (key figure, top left of Figure 3-13) using the database in the app. This resulted in detainment of he and two others as well as discovery of a weapons cache. This discovery thwarted a potential attack. The personnel and vehicle were processed using the app: photos and location, date time and metadata were captured.

Figure 3-13: August 9th - Database Use and Data Entry

Inferencing was demonstrated in test mode as well as on day 5, Friday, when we were able to script our own mini-scenario. The app alerted the Marines to anomolous 'traffic change' when the Marines 'saw' heavy traffic going from Village B to Village A, they saw a normal 'gathering' of people at the 'Mosque' for Friday prayer and 'person sighting' anomolies when key figures from Village B were 'seen' in Village A.

b. ***Look-ups***: Look-ups were used extensively to understand the meaning of signs and symbols. The meanings were helpful in questioning and gaining intel from locals and key figures.

"The Partnership of Nations is here to help Afghanistan"

"The time has come for all afghans to make peace"

Figure 3-14: August 10th - Propaganda and Sign Discernment

c. ***Visualization***: Although the maps and augmented reality were very well received during integration week, they weren't utilized much during execution of the scenario. It is believed this was partly due to the limitations of the scenario and available data as well as some difficulties in seeing the screen in sunlight.

2. ***Demonstrate the app working as part of the ISR Enterprise***: Messages were successfully sent from the phones, to DKKN, to GHUB and through the guard. Due to network realiabiltiy and congestion, messages didn't appear to be getting through early in the week. We re-validated that we had the correct schema, and Wednesday we were able to see some messages and Thursday, many. We don't have final numbers on how many Marine generated messages made it through because some phones were also generating test messages during vignettes. We have to go back and sort through all messages to find the final number.

   a. ***Integrated alerts with DKKN: to the CoC and other Android users***: Using the most current filters on DKKN and the latest Textron EntityName construct, we weren't able to see all alerts on DKKN. However, mid-week, Maj Filler was able to send an alert message from the Textron app, receiving it less than a minute later through the DKKN app. This demonstrated how the two apps work together, despite some minor filter and naming differences.

   b. ***Multimedia reachback***: Reachback was preliminarily tested at raytheon from PC to android which worked, but android-to android reachback contained a rendering issue that was unable to be resolved as it was a problem far within the source code of iJetty. Although the functionality was tested from Droid to PC, it was not used at EC10.

c. ***Messages succesfully cross the guard and are visible on Tactical Switchboard***: The Textron alerts and observations made it across the guard but it is unknown and unlikely that our messages made it all the way to tactical switchboard because we did not have the right contents in EntityName field. It was late in the week before we knew of this issue/change. We original thought that 'Alert' had to be the EntityName, but turns out it needed to contain an actual entity name (i.e. of a key figure).

3. ***Demonstrate output being consumed by other analysis tools***: As discussed already, we succesfully integrated with Raytheon's DKKN, both the 'regular' and app versions. Early on in the development cycle, we talked some with Metron, Chi, Los Alamos and Aptima about consuming our output. We went so far as sending them sample output, but in the crunch to prepare for the demonstration, I don't know if any of these performers actually implemented comsumption of our output.
4. ***Obtain feedback regarding usability and relevance top the Warfighter***: We received invaluable feedback from the Marines on Friday, August 13. We spent approximately 1 hour with them, simply learning about their roles as recon Marines and analysts. From that discussion we gleaned a lot of next steps, see section 4.

Scenario Development: We worked early and often with Kelli Kuduk to try and ensure we had a Nawa-esque scenario that would utilize our Nawa-focused geo-cultural and anthropological data stores. Unfortunately, given the limited actors and resources, much of what we discussed was not used, or was acted out in a limited way. We also had little information on building names/numbers, locations, usages.

Despite these challenges, we were able to adapt and present more capability than in the ISR-C2 demo in Hawaii last year.

4 RESULTS, CONCLUSIONS AND NEXT STEPS

Overall, Textron had a good showing at EC10. We were able to show utility of the various parts of our tool that provide geo-cultural context to the Warfighter. We also got a lot of invaluable feedback from the Marines. Additionaly we were able to make a lot of our own obeservations on functionality and utility when accompanying the Marines in the field. We have nine (9) key take aways that may fuel our next steps:

1. **Inferencing should be separated from the look-up and data entry tools.**

   On the final day, we spent some quality time with the Marines, learning of their various Warfighter roles and responsibilities. We learned that the Recon Marine simply observes and does not act unless told to. They can't act on an abnormal inference and therefore inferencing functionality is better suited for an analyst. However, both the Major and Lieutenant commanding the exercise indicated this functionality would be of importance to them if fully matured. The inferencing capabilities were appreciated by the Analysts. Recommendations from several of the Marines indicated that the software capabilities should be targeted at multiple echelon levels (e.g., low-level and high-level inferencing). From several discussions with the Marines during the course of the experiment it is fairly obvious that the functionality should be separated (maps, Vis, inference, geocultural data lookup) and each tool in our software system refined for the specific mission tasking and command level. Some discussions with ONR have hinted at a new *Strategic Corporal* type mindset, where an enhanced capability to the Marine could modify his ability to react to situations and understand his environment. A question for ONR here then is are we trying to support the current force Marine or are we trying to define the future force marine by enhancing his ability to act.

2. **Data entry needs to be simplified.**

   The Recon Marine would prefer desktop-level input screens or a default menu: text, audio, imagery that are tied together and/or who/what/where/when or SALUT-based entry fields. Remove the Q&A prompting that is currently needed for inferencing. Anything that prevents them from maintaining control of their weapons at all times could easily make them vulnerable to attack. Some mechanism to automate the input and output process (e.g., voice recognition) would be extremely helpful here.

3. **We should look into inferencing on sensor output.**

   This is complementary to #1. This year, we developed an inferencing tool that inferences on Marine input. After EC10, however, we understand that there are sensor systems that could give us more relevant input for inferencing and would also lessen the burden on the Warfighter (who stated that they want something that is three 'clicks' or less...more than that is too much).

   Inferencing on sensor input would however give us dependence on the network. TAVI and TINDER are two sensor providers that stood out as being able to provide us with input on which we could inference. Traffic patters, numbers of people in a place at a certain time, etc.

4. **Look-ups, integrated maps and augmented reality were well-received.**

Look-ups are a keeper! They were the most utlized portion of the tool.

The Marines and DV's really liked the mapping and augmented reality features; it would be a good idea to look into how we can make these more usable features. They were not used in EC10, perhaps due to scenario limitations.

5. **Use of state information.**

   State information is extremely important in providing inferencing capabilities and should be a requisite part of any further development efforts. This will provide the ability to correlate multiple events over time that are necessary to actually detect patterns and produce associated forward/backward chain inferences.

6. **Viz tool and other form factors.**

   The augmented reality tool displaying the relative locations of prior events made an immediate positive impact and was seen as a viable tool for ground-level and vehicular use. Regular (periodic or event-based) updating of the databases would be required and a different form-factor adopted that will provide additional viewing capability, especially in difficult lighting conditions. A side benefit of this is that the larger form-factor should reduce or eliminate many of the GUI and battery constraints that currently exist with the hand-held devices.

7. **Android connectivity and cohabitation.**

   The initially poor Wi-Fi reception of the Motorola Milestone (ONR-specified) Androids severely impacted further use of the Android tool. It also became quickly apparent that sharing application space with other participants led to confusion as to which application to use to generate and report which type of event had been observed. Some functionality (e.g., mapping) overlapped with other vendor's application capabilities. The Textron application did not require constant Wi-Fi communications and was still useful when the network was not. When the other applications failed to communicate with the command center, there was a major tendency for the Marines to cease use of the Android device entirely to the detriment of the Textron application. Later, during the second week of the experiment, a new set of Samsung Intercept Android phones were provided to the Marines for trial. Some communications issues still persisted, however, and it wasn't until the final day of the experimental vignettes that full functionality could be demonstrated. The previous events had a prejudicing, albeit realistic, effect on the resulting impressions of the software.

8. **The Geo-Cultural support of this tool is most useful in the first couple weeks of a deployment.**

   Generally, after a week or so, the Warfighter has a good sense of what is/isn't normal. This tool gives them a resource for the time when they are learning. They can carry the knowledge with them and not have to try to retain everything they learn in their training.

9. **Data Synching:**

   If we are going to continue providing the user with look-ups and data entry, we need a way to synch the data on all the Androids so that everyone has a complete and current data set. Rudementary data synching was done manually on the Key Figures database at EC10. This should be automated in the future.

10. Verbal Translation.

Verbal translation was greatly desired so that Marine could understand what a person was saying if they did not have a human translator with them. Processing time needs to be quick. An initial version of the Google Voice Actions app is available on the new Droid 2 platform released in early August. This multilanguage voice app is objectively planned as a language translator.

11. Network and Access Security.

If security is needed on Droid, Marine comment was to use fingerprint as pass code so that Marine does not have to type or remember another pass word. Textron is currently investigating Android security issues as an internally funded effort, both in terms of user access and platform access to distrbuted resources.

12. Tribe/Group/Clan Neighborhood Overlays.

Develop "roaming net" for groups (tribal, ethnic, racial, etc.) for map display that will inform user of the area said group is normally/typically found to move around in. This could help raise alerts if members of one group are found outside their typical area. For example, in the vignettes, Village B did not leave their village nor travel much in the area, so it was important to note when one of their members did leave the area. A map based application using simple spatial analysis could inform user when a person identified from one place is found outside of their typical "roaming territory" and aid in intel. Working with Chi Systems to leverage their map overlays woiuld be a desireable but difficult (security) way to proceed.

13. Alternate Data Display Approaches.

We might consider displaying normal events as a Calendar Schedule (similar to what you get with your Microsoft Outlook) with look-ups by date/hour.

14. Event Positioning.

Current system reports position of Android when making an observation. Need mechanism, perhaps map based to capture the position of an event or sighting if not the same as current user location.

15. Data Tailoring.

Need to tailor information delivered to Marine in the field by Commander's Intent, location, time of year and current political environment. Different anthropological/geo-cultural data is needed under different circumastances or environments.

16. Visual Search.

Akin to Google Goggles wherein marine takes picture of person, vehicle, object, activity, etc. and says "search" and application tells him/her what or who they are looking at and anything else they may need to know (HVP, abnormal activity, etc).

This short list of lessons from EC10 will help balance trade studies in the upcoming option year effort. Of most value in this exercise was getting the direct user feedback both functionally and doctrinally on all efforts to date.

5 Acronym List

Table 5-1: Acronym List

API	Application Programming Interface; Application Program Interface; Application Programmer Interface
C2	Command and Control
CLOC	Company Level Operations Center
DKKN	Distributed Knowledge and Knowledge Needs
EC10	Empire Challenge 2010
ERDC	Engineering Research and Development Center – US Army Corp of Eng.
GDII	Green Devil II
GIRH	Generic Intelligence Requirement Handbook
GUI	Graphical User Interface
ISR	Intelligence Surveillance and Reconnaissance
RBIE	Rules Based Inferencing Engine
RDF	Resource Description Framework
SME	Subject Matter Experts
SOAP	Simple Object Access Protocol
TIM	Technical Interchange Meeting
TUS	Transparent Urban Structures
XML	Extensible Markup Language